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A Computer Program for Counting Load Spectrum Cycles

based on the

Range Pair Cycle Counting Method

V. A. Tischler

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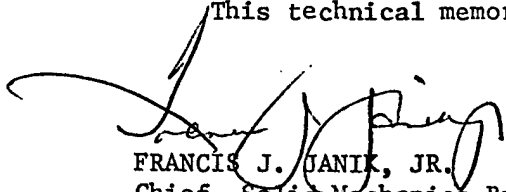
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## FOREWORD

This report was prepared by V.A. Tischler of the Solid Mechanics Branch, Structures Division, Air Force Flight Dynamics Laboratory. The work was conducted in-house under Project 1467, "Structural Analysis Methods," Task 146702, "Analysis Methods for Damaged Structures". Mr. Howard A. Wood is the Project Engineer.

The manuscript was released by the author in November 1972.

This technical memorandum has been reviewed and is approved.



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Chief, Solid Mechanics Branch  
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# ABSTRACT

This report presents a detailed description of a computer program based on the Range Pair Cycle Counting Method, as given in Reference 3. The Range Pair Cycle Counting Method is a procedure for generating an analysis spectrum from a given load spectrum. Examples are presented where the resulting analysis spectrum will be used as input to a crack growth analysis program.

## CONTENTS

Section		Page
I	Introduction	1
II	Program Organization	3
III	Input Instructions	5
IV	Tabular Output	6
References		7
Figures		8
Appendix I	Sample Problems	11
	1. 14 Mission C5-A A Spectrum	12
	2. 5.0g Flight by Flight Spectrum	33
Appendix II	Program Listing	40

## SECTION I

### INTRODUCTION

In crack propagation analysis it is necessary to have a correct representation of the load spectrum. A load spectrum obtained from tests may not be directly applicable to analysis. The Range Pair Cycle Counting Method is a means of determining an accurate analysis spectrum from the actual load spectrum. This method is briefly discussed and compared with other counting methods in References 1 and 2. A more comprehensive discussion which forms the basis for the development of the present computer program is given in Reference 3.

The computer program treats a load spectrum  $S$  as a collection of  $n$  peaks and valleys designated by  $x_i$ ,  $i = 1, \dots, 2n$ , such that if  $x_i$  is a peak then  $x_{i+1}$  is a valley,  $1 \leq i \leq 2n-1$ . The analysis spectrum is represented by a collection of  $m$  cycles  $\{(a, b)_i\}$ ,  $i = 1, \dots, m$ , such that  $a_i$  and  $b_i$  are elements of  $S$ . The Range Pair Cycle Counting Method considers four points  $(x_1, x_2, x_3, x_4)$  at a time and the conditions for counting a cycle  $(x_2, x_3)$  are as follows:

If  $x_2 > x_1$ , then a cycle is counted if

$$x_2 \leq x_4 \text{ and } x_3 \geq x_1.$$

Conversely, if  $x_2 < x_1$ , then a cycle is counted if

$$x_2 \geq x_4 \text{ and } x_3 \leq x_1.$$

This method is illustrated in Figure 1.

Thus, starting at the beginning of the load spectrum the first four points  $x_1, x_2, x_3$  and  $x_4$  are considered. If  $x_2$  and  $x_3$  meet the above conditions, a cycle is defined and these two points are deleted from the spectrum. Consequently  $x_4$  becomes  $x_2$  and the next two points of the spectrum are added to again give four points. Counting continues until the four points considered do not define a cycle. Then  $x_1$  is omitted from consideration and becomes an element of a residue spectrum. The three remaining points are updated, i.e.  $x_2$  becomes  $x_1$ ,  $x_3$  becomes  $x_2$ ,  $x_4$  becomes  $x_3$ , and  $x_4$  is added sequentially from the load spectrum. This process continues until there are only two or three points remaining. These points are added to the residue spectrum, which is then analyzed in the same manner as the original load spectrum. Continuing in this manner a residue spectrum is

finally generated which will yield no cycles by the Range Pair Cycle Counting Method. This residue spectrum diverges to a maximum range and then converges as shown in Figure 2. Cycles are generated from the final residue spectrum as follows: Pair the highest peak with the lowest valley to form a cycle. Then moving away from this cycle in both directions, each successive peak and valley are paired together. If there is an extra peak or valley left on either side, it is omitted. This counting method is illustrated in Figure 2.

In summary, an original load spectrum is analyzed using the Range Pair Cycle Counting Method to produce an analysis spectrum plus a final residue spectrum. This final residue spectrum is then analyzed by a pairing technique to determine the remaining cycles, which are then added to those previously counted. The result is a complete analysis spectrum for use in analytical predictions.

## SECTION II

### PROGRAM ORGANIZATION

The Range Pair Cycle Counting program, RPCM, assumes that the input load spectrum,  $S$ , is defined by  $n$  peaks and valleys,  $(x_i, y_i)$ , and  $n$  counters  $k_i$ ,  $i=1, \dots, n$ , where  $k_i$  is a count of the number of times the  $i$ th peak and valley are to be repeated sequentially. The program then assigns a step number  $j$ ,  $j=1, \dots, n$  to each peak and valley of  $S$ . Since the analysis spectrum is generated in disjoint parts, i.e. from the input load spectrum, from each residue spectrum, and from the final residue spectrum, the step numbers are used to sort the analysis spectrum relative to the sequencing of the initial load spectrum. Sequence becomes important particularly in crack growth analysis. When the counter  $k$  is less than 1, as can occur in a flight by flight load spectrum, the peak and valley associated with  $k$  is not analyzed by the program, but is transferred directly into the analysis spectrum and subsequently sequenced relative to its step number.

The program RPCM is divided into three parts. Each part is described below in a step-by-step manner.

#### Part I

1. The initial load spectrum  $S$  is adjusted by removing those peaks and valleys whose counter  $k$  is less than one.
2. The initial load spectrum  $S$  is further adjusted if for some  $i$ , the  $i$ th peak and valley are equal to the  $(i+1)$ th peak and valley, by maximizing the counter  $k_i$ .
3. The Range Pair Cycle Counting Method is now applied to the adjusted load spectrum,  $S$ . Program RPCM calls Subroutine DECIDE with four elements from  $S$ . Subroutine DECIDE determines whether a cycle is to be generated or whether  $x_1$  goes to the residue spectrum. Cycles are generated in Subroutine CYCGEN.

#### Part II

1. The Range Pair Cycle Counting Method is applied to the residue spectrum. Program RPCM calls Subroutine DECRES with four elements from the residue spectrum. Subroutine DECRES determines whether a cycle is to be generated or whether  $x_1$  goes to the next residue spectrum. Cycles are generated in Subroutine CYCRES.



2. If the current residue spectrum has less than three points or if no additional cycles can be generated by the Range Pair Cycle Counting Method, proceed to Part III, otherwise return to Step 1.

### Part III

1. The remaining cycles are generated from the final residue spectrum.

2. The analysis spectrum is sorted relative to the sequencing of the input load spectrum.

SECTION III  
INPUT INSTRUCTIONS

<u>Card No.</u> (Format)	<u>Variable Name</u>	<u>Definition</u>
1 (8A10)	TITLE	An alphanumeric description of the load spectrum, S
2 (2I5)	NPKS	Number of peaks or valleys in the load spectrum, S
	NPUNCH	Punch flag NPUNCH $\neq$ 0 implies the analysis spectrum will be punched in the input format.
3,...,NPKS+2 (5x,3E10.3)	SIGMAX(I)	Ith peak of the load spectrum, S
	SIGMIN(I)	Ith valley of the load spectrum, S
	RNCYC(I)	counter $k_i$ of the Ith peak and valley

SECTION IV  
TABULAR OUTPUT

Program RPCM gives the following output:

1. The input load spectrum, S.
2. The adjusted load spectrum as discussed in Section II.
3. The elements and step numbers of Residue Spectrum 1.
4. The elements, the step number and the counter k of the cycles generated from the adjusted load spectrum.
5. The elements and step numbers of Residue Spectrum 2.
6. Step 4 output is repeated plus any additional cycle information generated from Residue Spectrum 1.
7. Steps 5 and 6 are repeated for each residue spectrum until the final residue spectrum is generated.
8. All previous cycle output plus any additional cycle information generated from the final residue spectrum.
9. The Range Pair Cycle Counted spectrum, i.e., the analysis spectrum.

#### REFERENCES

1. J.B. de Jonge, "The Monitoring of Fatigue Loads," National Aerospace Laboratory NLR, The Netherlands, Report MP 70010 U.
2. N.E. Dowling, "Fatigue Failure Predictions for Complicated Stress - Strain Histories", University of Illinois, Urbana, T.&A.M., Report No. 337, January 1971.
3. S. Streitmatter, "A Method of Counting Spectrum Load Cycles", North American Rockwell, Los Angeles Division, TFD-72-358, March 1972.

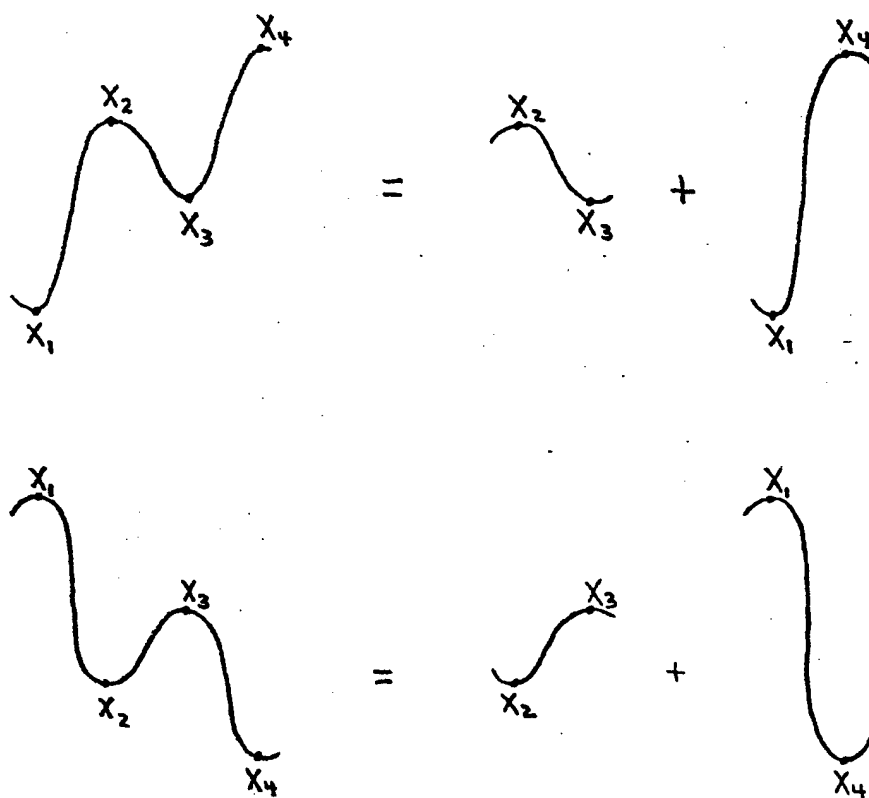


Figure 1

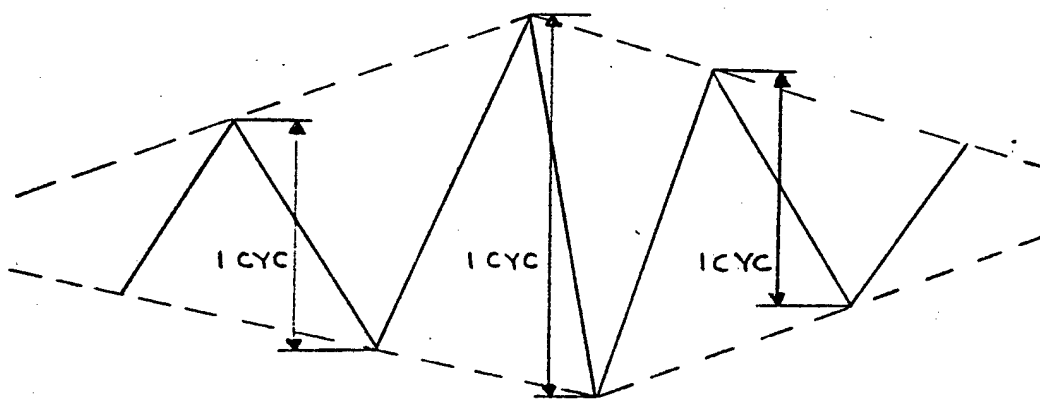


Figure 2

# PARTIAL SCHEMATIC OF THE 14 MISSION C5-A A SPECTRUM

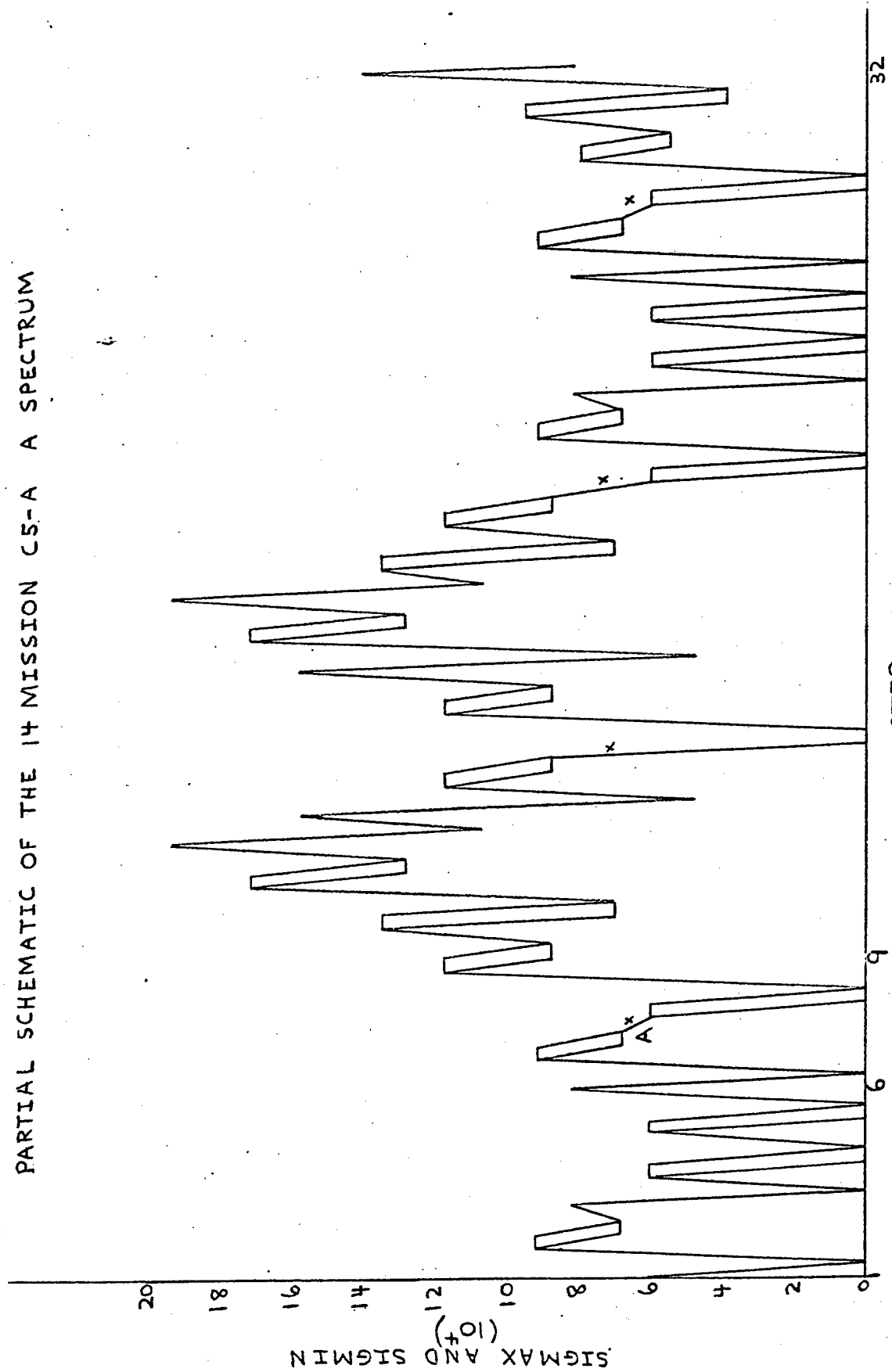


Figure 3

AN EXPANDED VIEW ABOUT  
THE POINT A OF THE  
LOAD SPECTRUM IN FIGURE 3

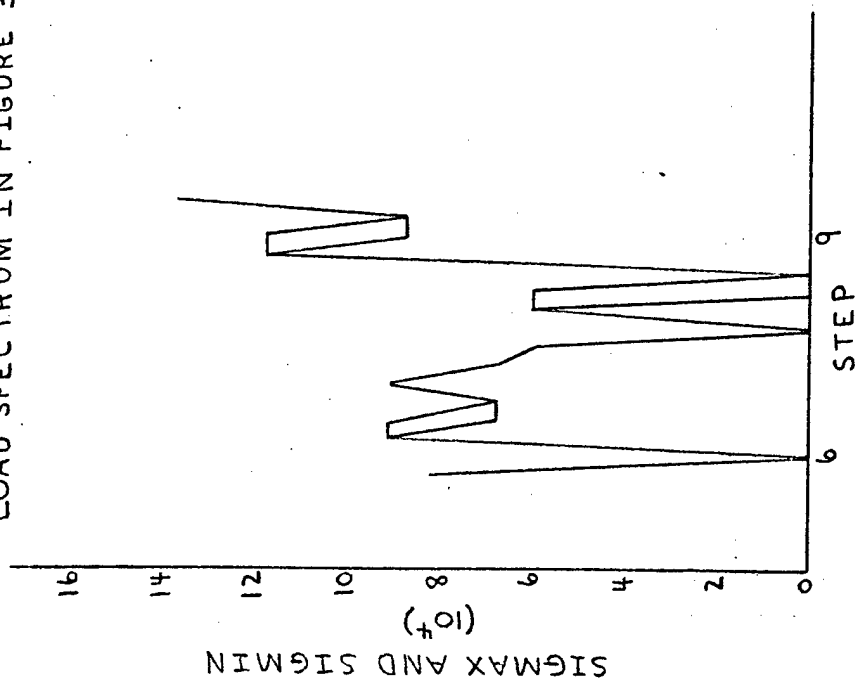


Figure 4

APPENDIX 1  
SAMPLE PROBLEMS



# 1. 14 Mission C5-A A Spectrum

A partial plot of the input load spectrum S is given in Figure 3. The full spectrum is listed on P . It has been observed that the spectrum listing may not be a good representation of the load spectrum since some of the peaks or valley values given in the spectrum listing do not match the actual peaks and valleys on the load spectrum. This can be illustrated by steps 6 through 9 of the spectrum listing.

6	8215.0	0.0	1
7	9146.0	6846.0	5
8	6065.0	0.0	12
9	11790.0	8790.0	50

The load spectrum that these 4 steps would produce is given in Figure 4. Now considering the actual peaks and valleys shown in Figure 4, steps 6 through 9 should become

8215.0	0.0	1
9146.0	6846.0	4
9146.0	0.0	1
6065.0	0.0	11
11790.0	8790.0	50

These five steps may now be range pair counted according to the rules given. The x's on Figure 3 indicate additional places where the above type of behaviour occurs.

The program as written can handle such discrepancies in the initial load spectrum.

## 14 MISSION C5-A A SPECTRUM

THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPECTRUM = 78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14	0.	0.	12.00000
2	.914630E+14	0.	.684600E+04	5.00000
3	.821590E+14	0.	0.	1.00000
4	.606500E+14	0.	0.	12.00000
5	.606500E+14	0.	0.	12.00000
6	.821500E+14	0.	0.	1.00000
7	.914600E+14	0.	.684600E+04	5.00000
8	.606500E+14	0.	0.	12.00000
9	.117900E+15	0.	.879330E+04	50.00000
10	.135400E+05	0.	.704000E+04	29.00000
11	.172000E+15	0.	.129000E+05	14.00000
12	.194600E+15	0.	.167300E+05	1.00000
13	.157900E+15	0.	.479000E+04	1.00000
14	.117900E+15	0.	.879330E+04	50.00000
15	.100300E+11	0.	0.	1.00000
16	.117900E+15	0.	.879000E+04	50.00000
17	.157900E+05	0.	.479000E+04	1.00000
18	.172000E+15	0.	.129000E+05	14.00000
19	.194600E+15	0.	.167300E+05	1.00000
20	.135400E+05	0.	.704000E+04	29.00000
21	.117900E+15	0.	.879000E+04	50.00000
22	.606500E+14	0.	0.	12.00000
23	.914600E+14	0.	.684600E+04	5.00000
24	.821500E+14	0.	0.	1.00000
25	.606500E+14	0.	0.	12.00000
26	.606500E+14	0.	0.	12.00000
27	.821500E+04	0.	0.	1.00000
28	.914630E+14	0.	.684600E+04	5.00000
29	.606500E+14	0.	0.	12.00000
30	.794700E+04	0.	.544700E+04	12.00000
31	.949700E+14	0.	.389700E+04	50.00000
32	.140000E+15	0.	.813000E+04	24.00000
33	.122500E+15	0.	.985000E+04	1.00000
34	.113970E+15	0.	.199700E+04	50.00000
35	.794700E+14	0.	.544700E+04	12.00000
36	.606500E+14	0.	0.	5.00000
37	.914600E+04	0.	.684600E+04	1.00000
38	.821500E+14	0.	0.	12.00000
39	.606500E+14	0.	0.	12.00000
40	.606500E+04	0.	0.	1.00000
41	.821500E+14	0.	.684600E+04	5.00000
42	.914600E+14	0.	0.	12.00000
43	.606500E+14	0.	0.	5.00000
44	.794700E+14	0.	.544700E+04	12.00000
45	.113970E+15	0.	.199700E+04	1.00000
46	.122500E+15	0.	.985000E+04	24.00000
47	.140000E+05	0.	.813000E+04	1.00000
48	.949700E+14	0.	.389700E+04	50.00000
49	.794700E+14	0.	.544700E+04	12.00000
50	.606500E+04	0.	0.	5.00000
51	.914600E+14	0.	.684600E+04	1.00000
52	.821500E+14	0.	0.	12.00000
53	.606500E+14	0.	0.	1.00000
54	.606500E+14	0.	0.	12.00000

55	.821500E+J4	0.	1.00000
56	.914600E+J4	.684600E+04	5.00000
57	.606500E+04	0.	12.00000
58	.117900E+J5	.879000E+04	50.00000
59	.135400E+J5	.704300E+04	29.00000
60	.172000E+05	.129000E+05	14.00000
61	.194000E+J5	.107000E+05	1.00000
62	.157900E+J5	.479300E+04	1.00000
63	.117900E+J5	.879000E+04	50.00000
64	.100000E+J1	0.	1.00000
65	.117900E+J5	.879000E+J4	50.00000
66	.157900E+J5	.479000E+04	1.00000
67	.172000E+05	.129000E+05	14.00000
68	.194000E+J5	.107000E+05	1.00000
69	.135400E+J5	.704300E+04	29.00000
70	.117900E+05	.879000E+04	50.00000
71	.606500E+J4	0.	12.00000
72	.914600E+J4	.684600E+04	5.00000
73	.821500E+J4	0.	1.00000
74	.606500E+J4	0.	12.00000
75	.914600E+J4	0.	12.00000
76	.821500E+J4	0.	1.00000
77	.914600E+J4	.684600E+04	5.00000
78	.606500E+J4	0.	12.00000

STEP NUMBERS OF IDENTICAL PEAKS AND VALLEYS WHICH OCCUR CONSECUTIVELY IN THE LOAD SPECTRUM

5 26 40 54 75

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+04		0.	12.00000
2	.914600E+04		.684600E+04	5.00000
3	.821500E+04		0.	1.00000
4	.606500E+04		0.	24.00000
5	.821500E+04		0.	1.00000
6	.914600E+04		.684600E+04	5.00000
7	.606500E+04		0.	12.00000
8	.117900E+05		.879000E+04	50.00000
9	.135400E+05		.704000E+04	29.00000
10	.172000E+05		.129000E+05	14.00000
11	.194000E+05		.107000E+05	1.00000
12	.157900E+05		.479000E+04	1.00000
13	.117900E+05		.879000E+04	50.00000
14	.100000E+05		0.	1.00000
15	.117900E+05		.879000E+04	50.00000
16	.157900E+05		.479000E+04	1.00000
17	.172000E+05		.129000E+05	14.00000
18	.194000E+05		.107000E+05	1.00000
19	.135400E+05		.704000E+04	29.00000
20	.117900E+05		.879000E+04	50.00000
21	.606500E+04		0.	12.00000
22	.914600E+04		.684600E+04	5.00000
23	.821500E+04		0.	1.00000
24	.606500E+04		0.	24.00000
25	.821500E+04		0.	1.00000
26	.914600E+04		.684600E+04	5.00000
27	.606500E+04		0.	12.00000
28	.117900E+05		.879000E+04	50.00000
29	.135400E+05		.704000E+04	29.00000
30	.172000E+05		.129000E+05	14.00000
31	.194000E+05		.107000E+05	1.00000
32	.157900E+05		.479000E+04	1.00000
33	.117900E+05		.879000E+04	50.00000
34	.100000E+05		0.	1.00000
35	.117900E+05		.879000E+04	50.00000
36	.157900E+05		.479000E+04	1.00000
37	.172000E+05		.129000E+05	14.00000
38	.194000E+05		.107000E+05	1.00000
39	.135400E+05		.704000E+04	29.00000
40	.117900E+05		.879000E+04	50.00000
41	.606500E+04		0.	12.00000
42	.914600E+04		.684600E+04	5.00000
43	.821500E+04		0.	1.00000
44	.606500E+04		0.	24.00000
45	.821500E+04		0.	1.00000
46	.914600E+04		.684600E+04	5.00000
47	.606500E+04		0.	12.00000
48	.117900E+05		.879000E+04	50.00000
49	.135400E+05		.704000E+04	29.00000
50	.172000E+05		.129000E+05	14.00000
51	.194000E+05		.107000E+05	1.00000
52	.157900E+05		.479000E+04	1.00000
53	.117900E+05		.879000E+04	50.00000
54	.100000E+05		0.	1.00000
55	.117900E+05		.879000E+04	50.00000
56	.157900E+05		.479000E+04	1.00000
57	.172000E+05		.129000E+05	14.00000
58	.194000E+05		.107000E+05	1.00000
59	.135400E+05		.704000E+04	29.00000
60	.117900E+05		.879000E+04	50.00000

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.194000E+15  
.157900E+15  
.117900E+15  
.100000E+11  
.117900E+05  
.157900E+15  
.172000E+15  
.194000E+15  
.135400E+15  
.117900E+15  
.606500E+14  
.914600E+14  
.821500E+14  
.606500E+14  
.821500E+04  
.914600E+14  
.606500E+14

.107000E+05  
.479000E+04  
.879000E+04  
0.  
.879000E+04  
.479000E+04  
.129000E+05  
.107000E+05  
.704000E+04  
.879000E+04  
0.  
.684600E+04  
0.  
0.  
0.  
.684600E+04  
0.

1.00000  
1.00000  
50.00000  
1.00000  
50.00000  
1.00000  
14.00000  
1.00000  
29.00000  
50.00000  
12.00000  
5.00000  
1.00000  
24.00000  
1.00000  
5.00000  
12.00000

VALUE	STEP
.506500E+04	1
0.	1
.314600E+04	2
0.	6
.314600E+04	7
0.	8
.194000E+05	12
.479000E+04	13
.117900E+05	14
0.	15
.194000E+05	19
.704000E+04	20
.117900E+05	21
0.	22
.314600E+04	23
0.	27
.314600E+04	28
0.	29
.140000E+05	32
.310000E+04	32
.122500E+05	33
.199700E+04	34
.794700E+04	35
0.	36
.314600E+04	37
0.	41
.314600E+04	42
0.	43
.140000E+05	47
.389700E+04	48
.794700E+04	49
0.	50
.314600E+04	51
0.	55
.314600E+04	56
0.	57
.194000E+05	61
.479000E+04	62
.117900E+05	63
0.	64
.194000E+05	68
.704000E+04	69
.117900E+05	70
0.	71
.314600E+04	72
0.	76
.314600E+04	77
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14		0.	11.00000
2	.914600E+14		.684600E+14	4.00000
3	.821500E+14		.684600E+14	1.00000
4	.606500E+14		0.	24.00000
5	.821500E+14		0.	1.00000
6	.914600E+14		.684600E+14	4.00000
7	.606500E+14		0.	11.00000
8	.117900E+15		.879000E+14	50.00000
9	.135400E+15		.704300E+14	29.00000
10	.172000E+15		.129000E+15	14.00000
11	.157900E+15		.107300E+15	1.00000
12	.117900E+15		.879000E+14	99.00000
13	.157900E+15		.479300E+14	1.00000
14	.172000E+15		.129000E+15	14.00000
15	.135400E+15		.107300E+15	1.00000
16	.117900E+15		.879000E+14	28.00000
17	.135400E+15		.704300E+14	49.00000
18	.172000E+15		.129000E+15	11.00000
19	.157900E+15		.107300E+15	4.00000
20	.117900E+15		.879000E+14	24.00000
21	.135400E+15		.704300E+14	1.00000
22	.172000E+15		.129000E+15	1.00000
23	.157900E+15		.107300E+15	4.00000
24	.117900E+15		.879000E+14	11.00000
25	.135400E+15		.704300E+14	50.00000
26	.172000E+15		.129000E+15	24.00000
27	.157900E+15		.107300E+15	23.00000
28	.117900E+15		.879000E+14	1.00000
29	.135400E+15		.704300E+14	49.00000
30	.172000E+15		.129000E+15	11.00000
31	.157900E+15		.107300E+15	4.00000
32	.117900E+15		.879000E+14	24.00000
33	.135400E+15		.704300E+14	1.00000
34	.172000E+15		.129000E+15	1.00000
35	.157900E+15		.107300E+15	4.00000
36	.117900E+15		.879000E+14	11.00000
37	.135400E+15		.704300E+14	50.00000
38	.172000E+15		.129000E+15	24.00000
39	.157900E+15		.107300E+15	23.00000
40	.117900E+15		.879000E+14	1.00000
41	.135400E+15		.704300E+14	49.00000
42	.172000E+15		.129000E+15	11.00000
43	.157900E+15		.107300E+15	4.00000
44	.117900E+15		.879000E+14	24.00000
45	.135400E+15		.704300E+14	1.00000
46	.172000E+15		.129000E+15	1.00000
47	.157900E+15		.107300E+15	4.00000
48	.117900E+15		.879000E+14	11.00000
49	.135400E+15		.704300E+14	50.00000
50	.172000E+15		.129000E+15	24.00000
51	.157900E+15		.107300E+15	23.00000
52	.117900E+15		.879000E+14	1.00000
53	.135400E+15		.704300E+14	49.00000
54	.172000E+15		.129000E+15	11.00000
55	.157900E+15		.107300E+15	4.00000
56	.117900E+15		.879000E+14	24.00000
57	.135400E+15		.704300E+14	1.00000
58	.172000E+15		.129000E+15	1.00000
59	.157900E+15		.107300E+15	4.00000
60	.117900E+15		.879000E+14	11.00000
61	.135400E+15		.704300E+14	50.00000
62	.172000E+15		.129000E+15	24.00000
63	.157900E+15		.107300E+15	23.00000

67	.157900E+05	.479000E+04	1.00000
67	.172000E+05	.129000E+05	14.00000
69	.135400E+05	.167000E+05	1.00000
69	.135400E+05	.704000E+04	28.00000
70	.117900E+05	.879000E+04	49.00000
71	.606500E+04	0.	11.00000
72	.914600E+04	.684600E+04	4.00000
73	.821500E+04	.684600E+04	1.00000
74	.606500E+04	0.	24.00000
76	.821500E+04	0.	1.00000
77	.914600E+04	.684600E+04	4.00000
78	.606500E+04	0.	11.00000



VALUE	STEP
.506500E+04	1
0.	1
.194000E+05	12
0.	15
.194000E+05	19
0.	29
.140000E+05	32
0.	43
.140000E+05	47
0.	57
.194000E+05	61
0.	64
.194000E+05	68
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14		0.	11.00000
2	.914600E+14		.684600E+04	4.00000
3	.821500E+14		.684600E+04	1.00000
4	.606500E+04		0.	24.00000
6	.821500E+14		0.	1.00000
7	.914600E+14		.684600E+04	4.00000
8	.606500E+14		0.	11.00000
9	.117900E+15		.879000E+04	50.00000
10	.135400E+15		.704000E+04	29.00000
11	.172000E+15		.129000E+05	14.00000
13	.157900E+15		.107000E+05	1.00000
14	.117900E+15		.879000E+04	99.00000
18	.157900E+15		.479000E+04	1.00000
18	.172000E+15		.129000E+05	14.00000
20	.135400E+15		.107000E+05	1.00000
20	.135400E+15		.704000E+04	28.00000
21	.117900E+15		.879000E+04	49.00000
22	.606500E+14		0.	11.00000
23	.914600E+14		.684600E+04	4.00000
24	.821500E+14		.684600E+04	1.00000
25	.606500E+14		0.	24.00000
27	.821500E+14		0.	1.00000
28	.914600E+14		.684600E+04	4.00000
29	.606500E+14		0.	11.00000
31	.794700E+14		.544700E+04	50.00000
31	.949700E+14		.389700E+04	24.00000
33	.122500E+05		.985000E+04	23.00000
34	.113970E+15		.885000E+04	1.00000
35	.794700E+14		.544700E+04	49.00000
36	.606500E+14		.544700E+04	1.00000
36	.606500E+14		0.	11.00000
37	.914600E+14		.684600E+04	4.00000
38	.821500E+14		.684600E+04	1.00000
39	.606500E+14		0.	24.00000
41	.821500E+14		0.	1.00000
42	.914600E+14		.684600E+04	4.00000
43	.606500E+14		0.	11.00000
44	.794700E+14		.544700E+04	50.00000
46	.113970E+15		.199700E+04	1.00000
46	.122500E+05		.985000E+04	24.00000
48	.949700E+14		.810000E+04	1.00000
48	.949700E+14		.389700E+04	23.00000
49	.794700E+14		.544700E+04	49.00000
50	.606500E+14		.544700E+04	1.00000
51	.606500E+14		0.	11.00000
51	.914600E+14		.684600E+04	4.00000
52	.821500E+14		.684600E+04	1.00000
53	.606500E+14		0.	24.00000
55	.821500E+14		0.	1.00000
56	.914600E+14		.684600E+04	4.00000
57	.606500E+14		0.	11.00000
58	.117900E+15		.879000E+04	50.00000
59	.135400E+15		.704000E+04	29.00000
60	.172000E+15		.129000E+05	14.00000
62	.157900E+15		.107000E+05	1.00000
63	.117900E+15		.879000E+04	99.00000

**22**

MEMBERS OF RESIDUE SPECTRUM 3 = 4

VALUE	STEP
.606500E+04	1
0.	1
.194000E+05	19
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14		0.	11.00000
2	.914600E+14		.684600E+04	4.00000
3	.821500E+14		.684600E+04	1.00000
4	.606500E+14		0.	24.00000
6	.821500E+14		0.	1.00000
7	.914600E+14		.684600E+04	4.00000
8	.606500E+14		0.	11.00000
9	.117900E+15		.879000E+04	50.00000
10	.135400E+15		.764300E+04	29.00000
11	.172300E+15		.129300E+05	14.00000
13	.157900E+15		.107000E+05	1.00000
14	.117900E+15		.879000E+04	99.00000
18	.157900E+15		.479000E+04	1.00000
19	.172000E+15		.129300E+05	14.00000
20	.135400E+15		.107000E+05	1.00000
20	.135400E+15		.704300E+04	28.00000
21	.117900E+15		.879000E+04	49.00000
22	.606500E+14		0.	11.00000
23	.914600E+14		.684600E+04	4.00000
24	.821500E+14		.684600E+04	1.00000
25	.606500E+14		0.	24.00000
27	.821500E+14		0.	1.00000
28	.914600E+14		.684600E+04	4.00000
29	.606500E+14		0.	11.00000
30	.794700E+14		.544700E+04	50.00000
31	.949700E+14		.389700E+04	24.00000
33	.122500E+15		.985000E+04	23.00000
34	.113970E+15		.585000E+04	1.00000
35	.794700E+14		.544700E+04	49.00000
36	.606500E+14		.544700E+04	1.00000
36	.606500E+14		0.	11.00000
37	.914600E+14		.684600E+04	4.00000
38	.821500E+14		.684600E+04	1.00000
39	.606500E+14		0.	24.00000
41	.821500E+14		0.	1.00000
42	.914600E+14		.684600E+04	4.00000
43	.606500E+14		0.	11.00000
44	.794700E+14		.544700E+04	50.00000
46	.113970E+15		.199700E+04	1.00000
46	.122500E+15		.985000E+04	24.00000
48	.949700E+14		.810000E+04	1.00000
48	.949700E+14		.389700E+04	23.00000
49	.794700E+14		.544700E+04	49.00000
50	.606500E+14		.544700E+04	1.00000
50	.606500E+14		0.	11.00000
51	.914600E+14		.684600E+04	4.00000
52	.821500E+14		.684600E+04	1.00000
53	.606500E+14		0.	24.00000
55	.821500E+14		0.	1.00000
55	.914600E+14		.684600E+04	4.00000
57	.606500E+14		0.	11.00000
58	.117900E+15		.879000E+04	50.00000
59	.135400E+15		.764300E+04	29.00000
60	.172300E+15		.129300E+05	14.00000
62	.157900E+15		.107000E+05	1.00000
63	.117900E+15		.879000E+04	99.00000

67	.157900E+15	.479000E+04	1.00000
67	.172000E+05	.129000E+05	14.00000
69	.135400E+15	.107000E+05	1.00000
69	.135400E+15	.704000E+04	28.00000
70	.117900E+15	.879000E+04	49.00000
71	.606500E+14	0.	11.00000
72	.914600E+14	.684600E+04	4.00000
73	.821500E+14	.684600E+04	1.00000
74	.606500E+14	0.	24.00000
76	.821500E+14	0.	1.00000
77	.914600E+14	.684600E+04	4.00000
78	.606500E+14	0.	11.00000
2	.914600E+14	0.	1.00000
7	.914600E+14	0.	1.00000
14	.117900E+15	.479000E+04	1.00000
21	.117900E+15	.704000E+04	1.00000
23	.914600E+14	0.	1.00000
28	.914600E+14	0.	1.00000
33	.122500E+15	.810000E+04	1.00000
35	.794700E+14	.199700E+04	1.00000
37	.914600E+14	0.	1.00000
42	.914600E+14	0.	1.00000
49	.794700E+14	.389700E+04	1.00000
51	.914600E+14	0.	1.00000
56	.914600E+14	0.	1.00000
63	.117900E+15	.479000E+04	1.00000
70	.117900E+15	.704000E+04	1.00000
72	.914600E+14	0.	1.00000
77	.914600E+14	0.	1.00000
12	.194000E+15	0.	1.00000
32	.140000E+15	0.	1.00000
47	.140000E+15	0.	1.00000
61	.194000E+15	0.	1.00000
68	.194000E+15	0.	1.00000

MEMBERS OF RESIDUE SPECTRUM 4 = 4

VALUE	STEP
.506500E+04	1
0.	1
.194000E+05	19
0.	78

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14		0.	11.00000
2	.914600E+14		.684600E+04	4.00000
3	.821500E+14		.684600E+04	1.00000
4	.606500E+14		0.	24.00000
6	.821500E+14		0.	1.00000
7	.914600E+14		.684600E+04	4.00000
8	.606500E+04		0.	11.00000
9	.117900E+15		.879000E+04	50.00000
10	.135400E+15		.704000E+04	29.00000
11	.172000E+05		.129000E+05	14.00000
13	.157900E+15		.167000E+05	1.00000
14	.117900E+15		.879000E+04	99.00000
16	.157900E+15		.479000E+04	1.00000
18	.172000E+15		.129000E+05	14.00000
20	.135400E+15		.107000E+05	28.00000
22	.135400E+15		.704000E+04	49.00000
24	.117900E+05		.879000E+04	11.00000
26	.606500E+14		0.	4.00000
28	.914600E+14		.684600E+04	1.00000
30	.821500E+14		.684600E+04	24.00000
32	.606500E+14		0.	1.00000
34	.794700E+14		.684600E+04	4.00000
36	.949700E+14		.544700E+04	11.00000
38	.122500E+15		.544700E+04	50.00000
40	.113970E+15		.544700E+04	1.00000
42	.113970E+15		.544700E+04	24.00000
44	.794700E+04		.684600E+04	1.00000
46	.949700E+04		.544700E+04	4.00000
48	.122500E+05		.544700E+04	11.00000
50	.949700E+14		.544700E+04	50.00000
52	.794700E+14		.544700E+04	1.00000
54	.606500E+14		.684600E+04	24.00000
56	.914600E+14		.684600E+04	1.00000
58	.821500E+14		.684600E+04	4.00000
60	.606500E+14		.684600E+04	11.00000
62	.914600E+14		.684600E+04	50.00000
64	.821500E+14		.684600E+04	1.00000
66	.606500E+14		.684600E+04	24.00000
68	.914600E+14		.684600E+04	1.00000
70	.821500E+14		.684600E+04	4.00000
72	.606500E+14		.684600E+04	11.00000
74	.914600E+14		.684600E+04	50.00000
76	.821500E+14		.684600E+04	1.00000
78	.606500E+14		.684600E+04	24.00000
80	.914600E+14		.684600E+04	1.00000
82	.821500E+14		.684600E+04	4.00000
84	.606500E+14		.684600E+04	11.00000
86	.914600E+14		.684600E+04	50.00000
88	.821500E+14		.684600E+04	1.00000
90	.606500E+14		.684600E+04	24.00000
92	.914600E+14		.684600E+04	1.00000
94	.821500E+14		.684600E+04	4.00000
96	.606500E+14		.684600E+04	11.00000
98	.914600E+14		.684600E+04	50.00000
100	.821500E+14		.684600E+04	1.00000



67	.157900E+J5	.479000E+J4	1.30000
67	.172000E+J5	.129000E+J5	14.00000
69	.135430E+J5	.107300E+J5	1.00000
69	.135430E+J5	.704030E+J4	28.00000
70	.117900E+J5	.879000E+J4	49.00000
71	.606500E+J4	0.	11.00000
72	.914600E+J4	.684600E+J4	4.00000
73	.821530E+J4	.684600E+J4	1.00000
74	.606500E+J4	0.	24.00000
76	.821530E+J4	0.	1.00000
77	.914600E+J4	.684600E+J4	1.00000
78	.606500E+J4	0.	4.00000
2	.914600E+J4	0.	1.00000
7	.914600E+J4	0.	1.00000
14	.117900E+J5	.479000E+J4	1.00000
21	.117900E+J5	.704000E+J4	1.00000
21	.914600E+J4	0.	1.00000
21	.914600E+J4	0.	1.00000
28	.914600E+J4	0.	1.00000
33	.122500E+J5	.840000E+J4	1.00000
35	.794730E+J4	.199730E+J4	1.00000
37	.914600E+J4	0.	1.00000
42	.914500E+J4	.389730E+J4	1.00000
49	.794700E+J4	0.	1.00000
51	.914500E+J4	0.	1.00000
56	.914500E+J4	0.	1.00000
63	.117900E+J5	.479000E+J4	1.00000
70	.117900E+J5	.704000E+J4	1.00000
72	.914600E+J4	0.	1.00000
77	.914600E+J4	0.	1.00000
12	.140000E+J5	0.	1.00000
32	.140000E+J5	0.	1.00000
47	.194300E+J5	0.	1.00000
61	.194300E+J5	0.	1.00000
68	.194300E+J5	0.	1.00000

## CYCLES GENERATED FROM LAST RESIDUE SPECTRUM - NO RANGE PAIR COUNTING = 2

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+14	0.	.634630E+04	11.00000
2	.914630E+14		.684600E+04	4.00000
3	.821500E+14		.684600E+04	1.00000
4	.606500E+14	0.		24.00000
5	.821500E+14	0.		1.00000
6	.914630E+14		.684630E+04	4.00000
7	.606500E+14	0.		11.00000
8	.117900E+15		.579300E+04	50.00000
9	.135400E+15		.74333E+04	29.00000
10	.172000E+05		.129000E+05	14.00000
11	.157900E+15		.129000E+05	1.00000
12	.117900E+15		.579300E+04	99.00000
13	.157900E+15		.479300E+04	1.00000
14	.172000E+15		.129000E+05	14.00000
15	.135400E+15		.129000E+05	1.00000
16	.157900E+15		.74333E+04	29.00000
17	.117900E+15		.579300E+04	50.00000
18	.135400E+15		.74333E+04	29.00000
19	.172000E+05		.129000E+05	14.00000
20	.157900E+15		.129000E+05	1.00000
21	.117900E+15		.579300E+04	99.00000
22	.157900E+15		.479300E+04	1.00000
23	.172000E+15		.129000E+05	14.00000
24	.135400E+15		.129000E+05	1.00000
25	.157900E+15		.74333E+04	29.00000
26	.117900E+15		.579300E+04	50.00000
27	.135400E+15		.74333E+04	29.00000
28	.172000E+15		.129000E+05	14.00000
29	.157900E+15		.129000E+05	1.00000
30	.117900E+15		.579300E+04	99.00000
31	.157900E+15		.479300E+04	1.00000
32	.172000E+15		.129000E+05	14.00000
33	.135400E+15		.129000E+05	1.00000
34	.157900E+15		.74333E+04	29.00000
35	.117900E+15		.579300E+04	50.00000
36	.135400E+15		.74333E+04	29.00000
37	.172000E+15		.129000E+05	14.00000
38	.157900E+15		.129000E+05	1.00000
39	.117900E+15		.579300E+04	99.00000
40	.157900E+15		.479300E+04	1.00000
41	.172000E+15		.129000E+05	14.00000
42	.135400E+15		.129000E+05	1.00000
43	.157900E+15		.74333E+04	29.00000
44	.117900E+15		.579300E+04	50.00000
45	.135400E+15		.74333E+04	29.00000
46	.172000E+05		.129000E+05	14.00000
47	.157900E+15		.129000E+05	1.00000
48	.117900E+15		.579300E+04	99.00000
49	.157900E+15		.479300E+04	1.00000
50	.172000E+15		.129000E+05	14.00000
51	.135400E+15		.129000E+05	1.00000
52	.157900E+15		.74333E+04	29.00000
53	.117900E+15		.579300E+04	50.00000
54	.135400E+15		.74333E+04	29.00000
55	.172000E+15		.129000E+05	14.00000
56	.157900E+15		.129000E+05	1.00000
57	.117900E+15		.579300E+04	99.00000
58	.157900E+15		.479300E+04	1.00000
59	.172000E+15		.129000E+05	14.00000
60	.135400E+15		.129000E+05	1.00000
61	.157900E+15		.74333E+04	29.00000
62	.117900E+15		.579300E+04	50.00000
63	.135400E+15		.74333E+04	29.00000
64	.172000E+15		.129000E+05	14.00000
65	.157900E+15		.129000E+05	1.00000
66	.117900E+15		.579300E+04	99.00000
67	.157900E+15		.479300E+04	1.00000
68	.172000E+15		.129000E+05	14.00000

69	.135400E+J5	.107000E+J5	1.00000
69	.135400E+J5	.704000E+04	28.00000
70	.117900E+J5	.879000E+J4	49.00000
71	.606500E+J4	0.	11.00000
72	.914600E+J4	.684600E+04	4.00000
73	.821500E+J4	.684600E+04	1.00000
74	.606500E+J4	0.	24.00000
76	.821500E+J4	0.	1.00000
77	.914600E+04	.684600E+04	1.00000
78	.606500E+J4	0.	11.00000
2	.914600E+J4	0.	1.00000
7	.914600E+J4	0.	1.00000
14	.117900E+J5	.479000E+J4	1.00000
21	.117900E+J5	.704000E+04	1.00000
23	.914600E+J4	0.	1.00000
28	.914600E+J4	0.	1.00000
33	.122500E+J5	.810000E+04	1.00000
35	.794700E+J4	.199700E+04	1.00000
37	.914600E+J4	0.	1.00000
42	.914600E+J4	0.	1.00000
49	.794700E+J4	.389700E+04	1.00000
51	.914600E+J4	0.	1.00000
56	.914600E+J4	0.	1.00000
63	.117900E+J5	.479000E+04	1.00000
70	.117900E+J5	.704000E+04	1.00000
72	.914600E+J4	0.	1.00000
77	.914600E+J4	0.	1.00000
12	.194000E+J5	0.	1.00000
32	.140000E+J5	0.	1.00000
47	.140000E+J5	0.	1.00000
61	.194000E+J5	0.	1.00000
68	.194000E+J5	0.	1.00000
19	.194000E+J5	0.	1.00000
1	.606500E+J4	0.	1.00000

# RANGE PAIR CYCLE COUNTED SPECTRUM

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.606500E+J4	0.	.684600E+04	12.00000
2	.914600E+J4	0.	.684600E+04	4.00000
3	.914600E+J4	0.	.684600E+04	1.00000
4	.821500E+J4	0.	.684600E+04	1.00000
5	.606500E+J4	0.	.684600E+04	24.00000
6	.821500E+04	0.	.684600E+04	1.00000
7	.914600E+J4	0.	.684600E+04	4.00000
8	.914600E+J4	0.	.684600E+04	1.00000
9	.606500E+04	0.	.684600E+04	1.00000
10	.117900E+J5	0.	.879300E+J4	11.00000
11	.135400E+J5	0.	.764300E+J4	50.00000
12	.172300E+J5	0.	.129000E+05	29.00000
13	.194000E+J5	0.	.129000E+05	14.00000
14	.157900E+J5	0.	.129000E+05	1.00000
15	.117900E+J5	0.	.129000E+05	1.00000
16	.117900E+05	0.	.129000E+05	99.00000
17	.157900E+J5	0.	.129000E+05	1.00000
18	.172300E+J5	0.	.129000E+05	1.00000
19	.194000E+05	0.	.129000E+05	14.00000
20	.135400E+J5	0.	.129000E+05	1.00000
21	.135400E+J5	0.	.129000E+05	1.00000
22	.117900E+J5	0.	.129000E+05	28.00000
23	.117900E+J5	0.	.129000E+05	49.00000
24	.606500E+J4	0.	.129000E+05	1.00000
25	.914600E+J4	0.	.129000E+05	1.00000
26	.914600E+04	0.	.129000E+05	4.00000
27	.821500E+J4	0.	.129000E+05	1.00000
28	.606500E+J4	0.	.129000E+05	1.00000
29	.821500E+04	0.	.129000E+05	24.00000
30	.914600E+J4	0.	.129000E+05	1.00000
31	.914600E+J4	0.	.129000E+05	4.00000
32	.606500E+J4	0.	.129000E+05	1.00000
33	.794700E+J4	0.	.129000E+05	1.00000
34	.949700E+J4	0.	.129000E+05	11.00000
35	.140000E+05	0.	.129000E+05	50.00000
36	.122500E+J5	0.	.129000E+05	24.00000
37	.122500E+J5	0.	.129000E+05	1.00000
38	.113970E+J5	0.	.129000E+05	1.00000
39	.794700E+J4	0.	.129000E+05	49.00000
40	.794700E+J4	0.	.129000E+05	1.00000
41	.606500E+J4	0.	.129000E+05	1.00000
42	.606500E+J4	0.	.129000E+05	1.00000
43	.914600E+J4	0.	.129000E+05	11.00000
44	.914600E+J4	0.	.129000E+05	4.00000
45	.821500E+04	0.	.129000E+05	1.00000
46	.606500E+J4	0.	.129000E+05	24.00000
47	.821500E+04	0.	.129000E+05	1.00000
48	.914600E+04	0.	.129000E+05	1.00000
49	.914600E+J4	0.	.129000E+05	4.00000
50	.606500E+J4	0.	.129000E+05	1.00000
51	.794700E+J4	0.	.129000E+05	11.00000
52	.113970E+J5	0.	.129000E+05	50.00000
53	.122500E+J5	0.	.129000E+05	1.00000
54	.140000E+J5	0.	.129000E+05	24.00000
55	.949700E+04	0.	.129000E+05	1.00000
56	.949700E+J4	0.	.129000E+05	1.00000

57	.794700E+14	.544700E+14	49.00000
58	.794700E+14	.389700E+04	1.00000
59	.606500E+14	.544700E+14	1.00000
60	.606500E+14	0.	11.00000
61	.914600E+14	.684600E+04	4.00000
62	.914600E+14	0.	1.00000
63	.821500E+14	.684600E+14	1.00000
64	.606500E+14	0.	24.00000
65	.821500E+14	0.	1.00000
66	.914600E+14	.684600E+14	4.00000
67	.914600E+14	0.	1.00000
68	.606500E+14	0.	11.00000
69	.117900E+15	.879000E+14	50.00000
70	.135400E+15	.704000E+14	29.00000
71	.172000E+15	.129000E+05	14.00000
72	.194000E+15	0.	1.00000
73	.157900E+15	.107000E+05	1.00000
74	.117900E+15	.879000E+04	99.00000
75	.117900E+15	.479000E+14	1.00000
76	.157900E+15	.479000E+14	1.00000
77	.172000E+15	.129000E+14	14.00000
78	.194000E+15	0.	1.00000
79	.135400E+15	.107000E+15	1.00000
80	.135400E+05	.704000E+04	28.00000
81	.117900E+15	.879000E+14	49.00000
82	.117900E+15	.704000E+14	1.00000
83	.606500E+14	0.	11.00000
84	.914600E+14	.684600E+14	4.00000
85	.914600E+14	0.	1.00000
86	.821500E+14	.684600E+14	1.00000
87	.606500E+14	0.	24.00000
88	.821500E+14	0.	1.00000
89	.914600E+04	.684600E+04	4.00000
90	.914600E+14	0.	1.00000
91	.606500E+14	0.	11.00000

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2. 5.0g Flight by Flight Spectrum

# 5.35 FLIGHT BY FLIGHT SPECTRUM

THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPECTRUM = 74

STEP	SIGMA	MAXIMUM	MINIMUM	COUNTER K
1		.423000E+12	.277000E+12	1.00000
2		.493000E+12	.231000E+12	1.00000
3		.396000E+12	.231000E+12	1.00000
4		.396000E+12	.231000E+12	1.00000
5		.493000E+12	.231000E+12	1.00000
6		.456000E+12	.230000E+12	1.00000
7		.479000E+12		1.00000
8		.423000E+12		1.00000
9		.283000E+12	.230000E+12	1.00000
10		.308000E+12	.152000E+12	1.00000
11		.583000E+12	.233000E+12	1.00000
12		.308000E+12	.152000E+12	1.00000
13		.308000E+12	.152000E+12	1.00000
14		.668000E+12	.236000E+12	1.00000
15		.456000E+12	.230000E+12	1.00000
16		.308000E+12	.152000E+12	1.00000
17		.308000E+12	.152000E+12	1.00000
18		.490000E+12	.227000E+12	1.00000
19		.308000E+12	.152000E+12	1.00000
20		.308000E+12	.152000E+12	1.00000
21		.345000E+12	.112000E+12	1.00000
22		.308000E+12	.152000E+12	1.00000
23		.308000E+12	.152000E+12	1.00000
24		.299000E+12	.111000E+12	1.00000
25		.299000E+12	.111000E+12	1.00000
26		.408000E+12	.116000E+12	1.00000
27		.504000E+12	.220000E+12	1.00000
28		.299000E+12	.111000E+12	1.00000
29		.299000E+12	.111000E+12	1.00000
30		.299000E+12	.111000E+12	1.00000
31		.408000E+12	.220000E+12	1.00000
32		.504000E+12	.116000E+12	1.00000
33		.408000E+12	.116000E+12	1.00000
34		.593000E+12	.220000E+12	1.00000
35		.517000E+12	.263000E+12	1.00000
36		.402000E+12	.263000E+12	1.00000
37		.402000E+12	.263000E+12	1.00000
38		.736000E+12	.263000E+12	1.00000
39		.778000E+12	.263000E+12	1.00000
40		.517000E+12	.263000E+12	1.00000
41		.517000E+12	.263000E+12	1.00000
42		.648000E+12	.203000E+12	1.00000
43		.648000E+12	.203000E+12	1.00000
44		.366000E+12	.198000E+12	1.00000
45		.366000E+12	.198000E+12	1.00000
46		.464000E+12	.143000E+12	1.00000
47		.395000E+12	.143000E+12	1.00000
48		.395000E+12	.143000E+12	1.00000
49		.307000E+12	.104000E+12	1.00000
50		.395000E+12	.143000E+12	1.00000
51		.498000E+12	.140000E+12	1.00000
52		.307000E+12	.104000E+12	1.00000
53		.307000E+12	.104000E+12	1.00000

54	.428000E+J2	.200000E+J2	1.00000
55	.502000E+J2	.200000E+J2	1.00000
56	.366000E+J2	.200000E+J2	1.00000
57	.564000E+J2	.200000E+J2	1.00000
58	.470000E+J2	.200000E+J2	1.00000
59	.526000E+J2	.200000E+J2	1.00000
60	.470000E+J2	.200000E+J2	1.00000
61	.254000E+J2	.470000E+J1	1.00000
62	.254000E+J2	-.160000E+J1	1.00000
63	.184000E+J2	-.160000E+J1	3.00000
64	.338000E+J2	.114000E+J2	1.00000
65	.336000E+J2	.151000E+J2	1.00000
66	.366000E+J2	.151000E+J2	1.00000
67	.396000E+J2	.230000E+J2	1.00000
68	.456000E+J2	.228000E+J2	1.00000
69	.306000E+J2	.151000E+J2	1.00000
70	.583000E+J2	.228000E+J2	1.00000
71	.366000E+J2	.151000E+J2	1.00000
72	.583000E+J2	.228000E+J2	1.00000
73	.366000E+J2	.222000E+J2	1.00000
74	.503000E+J2	.294000E+J2	2.00000

STEP NUMBERS OF IDENTICAL PEAKS AND VALLEYS WHICH OCCUR CONSECUTIVELY IN THE LOAD SPECTRUM

4 13 17 20 23 37 41 43 45 66



STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.42300E+02		.27730E+02	1.00000
2	.49300E+02		.23100E+02	1.00000
3	.39600E+02		.23100E+02	1.00000
5	.49300E+02		.23100E+02	1.00000
6	.45600E+02		.23100E+02	1.00000
7	.47900E+02		0.	1.00000
8	.34200E+02		0.	4.00000
9	.28300E+02		.23000E+02	1.00000
10	.30800E+02		.15200E+02	1.00000
11	.50300E+02		.23000E+02	1.00000
12	.30800E+02		.15200E+02	2.00000
14	.68000E+02		.23000E+02	1.00000
15	.45600E+02		.23000E+02	1.00000
16	.39600E+02		.15200E+02	4.00000
18	.49000E+02		.22700E+02	1.00000
19	.30800E+02		.15200E+02	2.00000
21	.34500E+02		.11200E+02	1.00000
22	.30800E+02		.15200E+02	2.00000
24	.29900E+02		.11100E+02	5.00000
25	.29900E+02		.22000E+02	4.00000
26	.40800E+02		.11600E+02	3.00000
27	.50400E+02		.22000E+02	1.00000
28	.29900E+02		.11600E+02	7.00000
29	.29900E+02		.22000E+02	13.00000
31	.40800E+02		.11600E+02	8.00000
32	.50400E+02		.22000E+02	5.00000
33	.40800E+02		.11600E+02	1.00000
34	.59300E+02		.23300E+02	1.00000
35	.51700E+02		.23300E+02	1.00000
36	.40200E+02		.20300E+02	2.00000
38	.73600E+02		.23300E+02	1.00000
39	.77800E+02		.23300E+02	1.00000
40	.51700E+02		.20300E+02	2.00000
42	.64500E+02		.20300E+02	2.00000
44	.36600E+02		.19900E+02	2.00000
46	.46400E+02		.14000E+02	1.00000
47	.29500E+02		.10400E+02	1.00000
48	.39500E+02		.14000E+02	5.00000
49	.30700E+02		.10400E+02	1.00000
50	.39500E+02		.10400E+02	1.00000
51	.49800E+02		.14000E+02	1.00000
52	.30700E+02		.10400E+02	6.00000
53	.30700E+02		.14000E+02	17.00000
54	.42800E+02		.20300E+02	1.00000
55	.50200E+02		.20300E+02	1.00000
56	.36600E+02		.20300E+02	1.00000
57	.56400E+02		.20300E+02	1.00000
58	.47000E+02		.20300E+02	1.00000
59	.52800E+02		.20300E+02	1.00000
60	.47000E+02		.20300E+02	1.00000
61	.25400E+02		.47000E+02	1.00000
62	.25400E+02		-.16200E+02	1.00000
63	.18400E+02		-.16200E+02	1.00000
64	.33800E+02		.11400E+02	3.00000

65	.306000E+12	.151000E+02	2.00000
67	.396000E+12	.230000E+02	1.00000
68	.456000E+12	.280000E+02	1.00000
69	.306000E+12	.151000E+02	1.00000
70	.583000E+12	.280000E+02	1.00000
71	.306000E+12	.151000E+02	1.00000
72	.583000E+12	.280000E+02	1.00000
73	.366000E+12	.220000E+02	1.00000
74	.503000E+12	.294000E+02	2.00000

# RANGE PAIR CYCLE COUNTED SPECTRUM

STEP	MAXIMUM	SIGMA	MINIMUM	COUNTER K
1	.42300E+12		.27700E+02	1.00000
2	.49300E+12		3.	1.00000
3	.39600E+12		.23100E+02	2.00000
4	.49300E+12		.23100E+02	1.00000
5	.45600E+12		.23100E+02	1.00000
6	.47900E+12		.23000E+02	1.00000
7	.34200E+12		3.	4.00000
8	.28300E+12		.23000E+02	1.00000
9	.30800E+12		.15200E+02	1.00000
10	.59300E+12		.15200E+02	1.00000
11	.30800E+12		.23000E+02	1.00000
12	.30800E+12		.15200E+02	1.00000
13	.66800E+12		.22000E+01	1.00000
14	.45600E+12		.23000E+02	1.00000
15	.30800E+12		.23000E+02	1.00000
16	.30800E+12		.15200E+02	1.00000
17	.49000E+12		.15200E+02	1.00000
18	.30800E+12		.22700E+02	1.00000
19	.30800E+12		.15200E+02	1.00000
20	.34500E+12		.15200E+02	1.00000
21	.30800E+12		.15200E+02	1.00000
22	.30800E+12		.11200E+02	1.00000
23	.29900E+12		.15200E+02	1.00000
24	.29900E+12		.11000E+02	5.00000
25	.29900E+12		.22000E+01	3.00000
26	.40800E+12		.11600E+02	3.00000
27	.50400E+12		.22000E+01	1.00000
28	.29900E+12		.11600E+02	7.00000
29	.29900E+12		.22000E+01	13.00000
30	.29900E+12		.11600E+02	3.00000
31	.40800E+12		.22000E+01	5.00000
32	.50400E+12		.11600E+02	1.00000
33	.40800E+12		.11600E+02	1.00000
34	.59300E+12		.22000E+01	1.00000
35	.51700E+12		.22000E+02	1.00000
36	.40200E+12		.22000E+02	2.00000
37	.73600E+12		.20300E+02	1.00000
38	.77800E+12		.16000E+01	1.00000
39	.51700E+12		.22000E+02	2.00000
40	.64800E+12		.22000E+02	2.00000
41	.36600E+12		.22000E+02	1.00000
42	.36600E+12		.19300E+02	1.00000
43	.46400E+12		.19800E+02	1.00000
44	.39500E+12		.16400E+02	1.00000
45	.29500E+12		.14000E+01	5.00000
46	.30700E+12		.16400E+02	11.00000
47	.39500E+12		.10400E+02	1.00000
48	.49800E+12		.14300E+02	1.00000
49	.30700E+12		.14300E+02	1.00000
50	.30700E+12		.14000E+01	17.00000
51	.42800E+12		.20000E+02	1.00000
52	.50200E+12		.20000E+02	1.00000
53	.36600E+12		.20000E+02	1.00000
54	.50400E+12		.14300E+01	1.00000
55	.47800E+12		.20000E+02	1.00000

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.52600E+12  
.47000E+12  
.25400E+12  
.25400E+12  
.18400E+12  
.33800E+12  
.33600E+12  
.39600E+12  
.45600E+12  
.30600E+12  
.58300E+12  
.36500E+12  
.50300E+12

.20000E+02  
.20000E+02  
.20000E+02  
.47000E+11  
-  
.16000E+01  
.11400E+12  
.15100E+12  
.23000E+02  
.15100E+02  
.22800E+02  
.15100E+02  
.22200E+02  
.22800E+12  
.29400E+12

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**APPENDIX II**  
**PROGRAM LISTING**

PROGRAM RPCM(INPUT,TAP5=INPUT,OUTPUT,TAP5=OUTPUT,PUNCH)

THIS PROGRAM EMPLOYS THE RANGE PAIR CYCLE COUNTING METHOD TO GENERATE AN ANALYSIS SPECTRUM FROM A GIVEN LOAD SPECTRUM

INPUT  
CARD 1.  
TITLE = DESCRIPTION OF THE INPUT LOAD SPECTRUM, S  
FORMAT 8A10  
NPKS = NUMBER OF PEAKS OR VALLEYS IN THE  
LOAD SPECTRUM  
NPUNCH = PUNCH FLAG SUCH THAT NPUNCH  
NOT EQUAL TO ZERO IMPLIES PUNCH  
IN THE RANGE PAIR COUNTED SPECTRUM  
IN THE INPUT FORMAT

CARDS 3,...,NPKS+2.  
FORMAT 2I5  
SIGMAX(I) = ITH PEAK OF THE LOAD SPECTRUM  
SIGMIN(I) = ITH VALLEY OF THE LOAD SPECTRUM  
RNCYC(I) = COUNTER K OF THE ITH PEAK AND VALLEY  
FORMAT 5X,3E10.0

PROGRAM ARRAYS  
(INFORMATION NEEDED TO CHANGE DIMENSIONS)

ARRAY NAME	DEFINITION	DIMENSION
SIGMAX	PEAKS OF THE INPUT LOAD SPECTRUM	NPKS + KK
SIGMIN	VALLEYS OF THE INPUT LOAD SPECTRUM	NPKS + KK
RNCYC	K COUNTERS OF THE PEAKS AND VALLEYS	NPKS + KK
NNSTEP	STEP NUMBERS OF THE INPUT SPECTRUM	2*NPKS
RES	RESIDUE SPECTRUM	2*NPKS
INDEX	STEP NUMBERS OF ELEMENTS IN RES	NPKS + KK
RNECYC	K COUNTERS OF THE CYCLES OF THE	NPKS + KK
NNSTEP	UNSORTED ANALYSIS SPECTRUM	NPKS + KK
ISAVE	UNSORTED ANALYSIS SPECTRUM	99
	VALUES OF NSTEP(J) SUCH THAT RNCYC(J)	
	IS < 1.0 AND VALUES OF NSTEP(J) SUCH	
	THAT SIGMAX(J-1) = SIGMAX(J) AND	
	SIGMIN(J-1) = SIGMIN(J)	

COMMON/MDEC/SIGMAX(900),SIGMIN(900),NSTEP(900),LR,KMAX,KMIN,K31  
COMMON/MDEC/RES(1400),INDEX(1400),IND1,IND2,IND3,IND4,KIND  
COMMON/RNCYC/CYC(900,2),RNECYC(900),NNSTEP(900)  
COMMON/PCGDE/L,LIND  
DIMENSION RNCYC(900),ISAVE(99),TITLE(8)

9999 NPUNCH = 0  
READ(5,10) (TITLE(I), I = 1,8)  
IF (EOF(5)) 9000,9100  
10 FORMAT(8A10)  
9000 STOP  
9100 READ(5,95) NPKS,NPUNCH  
95 FORMAT(1X15)

```

60 READ(5,101) (SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,NPKS)
   101 FORMAT(5X,3E10.3)
   DO 800 J = 1,NPKS
800  NSTEP(I) = I
   WRITE(6,19) (TITLE(I), I = 1,9)
   19 FORMAT(1H1,8A10)
   WRITE(6,20) NPKS
23  FORMAT(1H3,60THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD) SPE
   19TRUM = ,15//
   WRITE(6,22)
22  FORMAT(63X,5HSIGMA/31X,4HSTEP,13X,7HMAXIMUM,16X,7HMINIMUM,13X,
   1 9HCCOUNTER K/)
   WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,NPKS)
25  FORMAT(29X,15,10X,E13.6,10X,E13.6,10X,F10.5)

70 C
   C SORT THROUGH THE LOAD SPECTRUM - PULL OUT THOSE PEAKS AND VALLEYS WHOSE
   C COUNTER K IS LESS THAN 1.0
   C
   J = 1
   L = 0
   NPES = 1
   NCYNO = 100
   JMAX = 0
   DO 100 I = 1,NPKS
   IF (RNCYC(I) .GE. 1.0) GO TO 100
   X1 = SIGMAX(I)
   X2 = SIGHIN(I)
   CALL CYCGEN(X1,X2 ,RNCYC(I),NSTEP(I))
   ISAVE(I) = I
   J = J + 1
100 CONTINUE
   JMAX = J - 1
   NPKSN = NPKS - JMAX
   IF (JMAX .EQ. 0) GO TO 200
   WRITE(6,23) (ISAVE(K), K = 1,JMAX)
23  FORMAT(1H0,9HSTEP NUMBERS OF THOSE PEAKS AND VALLEYS IN THE LOAD
   1 SPECTRUM WHOSE COUNTER K IS LESS THAN 1.0//17I)
   DO 110 J = 1,JMAX
   I = ISAVE(J) - (J-1)
   NPKN = NPKS - J
   IF (I .EQ. NPKN) GO TO 110
   DO 115 II = I,NPKN
   SIGMAX(II) = SIGMAX(II+1)
   SIGHIN(II) = SIGHIN(II+1)
   NSTEP(II) = NSTEP(II+1)
   RNCYC(II) = RNCYC(II+1)
115 CONTINUE
110 CONTINUE
   WRITE(6,24) NPKSN
   WRITE(6,22)
   WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,NPKSN)
200 CONTINUE

110 C
   C SORT THROUGH THE LOAD SPECTRUM DATA - COMBINE STEPS WITH IDENTICAL PEAKS
   C AND VALLEYS WHICH OCCUR CONSECUTIVELY
   C

```

C

115      J = 1  
          DC 300 I = 2,NPKSN  
          IF (SIGMAX(I) .NE. SIGMAX(I-1)) GO TO 300  
          IF (SIGMIN(I) .NE. SIGMIN(I-1)) GO TO 300  
          ISAVE(J) = I  
          RNCYC(I-1) = RNCYC(I-1) + RNCYC(I)  
          J = J + 1

120      300 CONTINUE  
          IF (J .EQ. 1) GO TO 6000  
          JMAS = J - 1

125      WRITE(6,26) (ISAVE(K), K = 1,JMAS)  
          26 FORMAT(1H0,90HSTEP NUMBERS OF IDENTICAL PEAKS AND VALLEYS WHICH OC  
          1CUR CONSECUTIVELY IN THE LOAD SPECTRUM// (17I7))  
          DO 311 J = 1,JMAS

130      I = ISAVE(J) - (J-1)  
          NPKN = NPKSN - J  
          IF (I .EQ. NPKN) GO TO 311  
          DC 316 II = 1,NPKN  
          SIGMAX(II) = SIGMAX(II+1)  
          SIGMIN(II) = SIGMIN(II+1)  
          NSTEP(II) = NSTEP(II+1)  
          RNCYC(II) = RNCYC(II+1)

135      316 CONTINUE  
          311 CONTINUE

NPKSN = NPKSN - JMAS

WRITE(6,24) NPKSN

24 FORMAT(1H1,54HLOAD SPECTRUM DATA ADJUSTED FOR RANGE PAIR COUNTING

1 = ,15//)

WRITE(6,22)

WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGMIN(I),RNCYC(I), I = 1,NPKSN)

C      RANGE PAIR COUNT THE ADJUSTED LOAD SPECTRUM  
     C

145      6000 I = 1

K8 = 1

L = JMAX

KMIN = 0

KMAX = 0

LR = C

K31 = 0

1 IF (RNCYC(I) .GT. 1.0) GO TO 400

IF (K8 .NE. 0) GO TO 5

X1 = SIGMAX(I)

X2 = SIGMIN(I)

IND1 = NSTEP(I)

IND2 = IND1

I = I + 1

K8 = 1

GO TO 1

5 X3 = SIGMAX(I)

X4 = SIGMIN(I)

IND3 = NSTEP(I)

IND4 = IND3

KMIN = 1



```

170      KMAX = 0
        K31 = 0
        IF (RNCYC(I) .EQ. 1.0) GO TO 5
        KEY = 1
        KIND = 1
        GO TO 415
        6 KEY = 0
        CYCNO = RNCYC(I)
        CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
175      1000 GO TO (12,13,30), KCYGEN
        13 KB = 1
        IF (KMIN .NE. 1) GO TO 36
        I = I + 1
        IF (I .LE. NPKSN) GO TO 5
        RES(LR+1) = X1
        RES(LR+2) = X2
        INDEX(LR+1) = IND1
        INDEX(LR+2) = IND2
        LRMAX = LR + 2
        GO TO 200J
195      30 IF (KMIN .NE. 1) GO TO 35
        12 I = I + 1
        IF (I .LE. NPKSN) GO TO 31
        RES(LR+1) = X1
        RES(LR+2) = X2
        RES(LR+3) = X3
        INDEX(LR+1) = IND1
        INDEX(LR+2) = IND2
        INDEX(LR+3) = IND3
        LRMAX = LR + 3
        GO TO 200J
        31 X4 = SIGMAX(I)
        IND4 = NSTEP(I)
        KMAX = 1
        KMIN = 0
        K31 = 1
230      32 IF (RNCYC(I) .GT. 1.0) GO TO 40
        40 KEY = 1
        KIND = 0
        GO TO 415
205      35 X4 = SIGMIN(I)
        IND4 = NSTEP(I)
        KMIN = 1
        KMAX = 0
        K31 = 0
        GO TO 32
210      36 X3 = SIGMIN(I)
        IND3 = NSTEP(I)
        KMIN = 1
        KMAX = 0
        GO TO 12
215      400 KEY = 1
        IF (KB .NE. 0) GO TO 410
        X1 = SIGMAX(I)
220

```

PROGRAM RPCM TRACE

X2 = SIGMIN(I)  
X3 = SIGMAX(I)  
X4 = SIGMIN(I)  
IND1 = NSTEP(I)  
IND2 = IND1  
IND3 = IND1  
IND4 = IND1  
KMIN = 1  
KMAX = 0  
K31 = 0

IF (RNCYC(I) .LE. 2.0) GO TO 491  
RNCYC(I) = RNCYC(I) - 1.0  
GO TO 402

401 RNCYC(I) = RNCYC(I) - 2.0  
402 KMIN = 0  
GO TO 415

410 X3 = SIGMAX(I)  
X4 = SIGMIN(I)  
IND3 = NSTEP(I)  
IND4 = IND3  
KMIN = 1  
KMAX = 0  
K31 = 0  
KIND = 1  
RNCYC(I) = RNCYC(I) - 1.0  
K2 = 0

415 CYCNO = RNCYC(I)  
CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)  
GO TO 1000

2000 LMAX = L  
WRITE(6,2001) NRES,LMAX  
2001 FORMAT(1H1,27HMEMBERS OF RESIDUE SPECTRUM,I5,3H = , I5//,55X,  
15HVALUE,10X,4HSTEP//)  
WRITE(6,2002) (RES(J),INDEX(J), J = 1,LMAX)

2102 FOPMAT(50X,E15.6,10X,I5)  
WRITE(6,2103) NRES,LMAX  
2103 FOPMAT(1H1,40HCYCLES GENERATED BEFORE RESIDUE SPECTRUM,I5,3H = ,  
115//)  
WRITE(6,22)  
WRITE(6,25) (NNSTEP(I),CYCLE(I,1),CYCLE(I,2),RNECYC(I),  
I = 1,LMAX)

1 IF (LRMAX .LT. 4) GO TO 5000  
IF (NCYNO .EQ. 0) GO TO 5300

C RANGE PAIR COUNT OF RESIDUE SPECTRUMS

NRES = NRES + 1  
CALL DECRES(LRMAX,NCYNO)  
GO TO 2000

5300 IF (LRMAX .LE. 1) GO TO 3000

C COUNT THE LAST RESIDUE SPECTRUM - RANGE PAIR COUNTING WILL YIELD NO  
C ADDITIONAL CYCLES

KK = 0

```

280 RESMAX = RES(1)
    RESMIN = RES(1)
    IMAX = 1
    IMIN = 1
    DO 500 I = 2,LRMAX
    IF (RES(I) .LT. RESMAX) GO TO 490
    RESMAX = RES(I)
    IMAX = I
    GO TO 580
295 490 IF (RES(I) .GT. RESMIN) GO TO 500
    RESMIN = RES(I)
    IMIN = I
    500 CONTINUE
    CALL CYCRES(RESMAX,RESMIN,1.0,INDEX(IMAX))
    KK = KK + 1
    510 J = IMAX - 2
    IF (J .LE. 3) GO TO 550
    CALL CYCRES(RES(J),RES(J+1),1.0,INDEX(J))
    KK = KK + 1
    INAX = J
    295 GO TO 510
    550 J = IMIN + 2
    IF (J .GT. LRMAX) GO TO 575
    CALL CYCRES(RES(J-1),RES(J),1.0,INDEX(J-1))
    KK = KK + 1
    IMIN = J
    GO TO 550
    575 KMAX = KK
    LMAX = L
    305 WRITE(6,2005) KMAX
    2005 FORMAT(1H1,71HCYCLES GENERATED FROM LAST RESIDUE SPECTRUM - NO RAN
    1GE PAIR COUNTING = ,15)
    WRITE(6,22)
    WRITE(6,25) (NNSTEP(I),CYCLE(I,1),CYCLE(I,2),RNECYC(I),
    1 I = 1,LMAX)
    C
    C
    C
    310 SORT THE ANALYSIS SPECTRUM TO PRODUCE THE RANGE PAIR COUNTED SPECTRUM
    300 KP = 0
    DO 605 JJ = 1,NPKS
    KC = 0
    DO 600 I = 1,LMAX
    IF (NNSTEP(I) .NE. JJ) GO TO 500
    KP = KP + 1
    KC = KC + 1
    NSTEP(KP) = KP
    SIGNAX(KP) = CYCLE(I,1)
    SIGNIN(KP) = CYCLE(I,2)
    RNECYC(KP) = RNECYC(I)
    325 IF (KC .LT. 2) GO TO 600
    IF (SIGNAX(KP) .NE. SIGNAX(KP-1)) GO TO 600
    IF (SIGNIN(KP) .NE. SIGNIN(KP-1)) GO TO 600
    595 KP = KP - 1
    RNECYC(KP) = RNECYC(KP) + 1.0
    600 CONTINUE

```

605 CONTINUE

KPMAX = KP

WRITE(6,2010)

2010 FORMAT(1H1,48X,33H RANGE PAIR CYCLE COUNTED SPECTRUM//)

WRITE(6,22)

WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGHIN(I),RNCYC(I),I = 1,KPMAX)

IF (NPUNCH .EQ. 0) GO TO 999

PUNCH 102, (SIGMAX(I),SIGHIN(I),RNCYC(I), I = 1,KPMAX)

102 FORMAT(5X,3F10.2)

GO TO 999

END

340

335

SUBROUTINE DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)  
COMMON/MDECA/SIGMAX(900),SIGNI(900),NSTEP(900),LR,KMAX,KMIN,K31  
COMMON/MDECR/RES(1400),INDEX(1400),IND1,IND2,IND3,IND4,KIND  
COMMON/MCYG/CYCLE(900,2),RNECYC(900),NNSTEP(900)  
COMMON/MCGDE/L,LIND

THIS SUBROUTINE DECIDES WHETHER OR NOT THE VALUES X1,X2,X3, AND X4  
FROM THE ADJUSTED LOAD SPECTRUM SATISFY THE RANGE PAIR COUNTING CONDITIONS

```

5      KFIRST = 0
10     IF (K31.NE. 0) GO TO 11
11     IF (X3.LE. X2) GO TO 200
11     IF (X2.GT. X1) GO TO 210
15     IF (X2.LT. X4.OR. X3.GT. X1) GO TO 500
150    IF (X2.GT. X3) GO TO 151
      CALL CYCGEN(X3,X2,1.0,NSTEP(I))
      GO TO 152
151    CALL CYCGEN(X2,X3, 1.0,NSTEP(I))
152    X1 = X1
      X2 = X4
      IF (IND3.NE. IND2) LIND = 1
      IND2 = IND4
      KCYGEN = 1
      IF (KEY.NE. 0) GO TO 110
      RETURN
210    IF (X2.GT. X4.OR. X3.LT. X1) GO TO 500
200    X1 = X1
      X2 = X4
      IND2 = IND4
      KCYGEN = 2
      IF (KEY.EC. 0) RETURN
      CYCNO = CYCNO - 1.0
      GO TO 110
35     C      ADD X1 TO THE RESIDUE SPECTRUM
      C
      C      500 LR = LR + 1
      RES(LR) = X1
      INDEX(LR) = IND1
      X1 = X2
      X2 = X3
      X3 = X4
      IND1 = IND2
      IND2 = IND3
      IND3 = IND4
      KCYGEN = 3
      IF (KEY.NE. 0) GO TO 110
      RETURN
110    GO TO (1150,1200,1500),KCYGEN
1150    IF (CYCNO.GT. 1.0) GO TO 1151
      IF (CYCNO.EQ. 0.0) RETURN
1153    CYCNO = CYCNO - 1.0
      GO TO 1152
1151    IF (LIND.EQ. 1) GO TO 1153

```

```

60      IF (IND3 .NE. IND4) GO TO 1153
        RNECYC(L) = RNECYC(L) + CYCNO - 2.0
        CYCNO = 1.0
1152    IF (KMAX .NE. 1) GO TO 111
        X3 = SIGMIN(I)
        IND3 = NSTEP(I)
        IF (CYCNO .NE. 0.0) GO TO 112
        KMIN = 1
        KMAX = 0
        KCYGEN = 3
        RETURN
1200    IF (CYCNO .EQ. 0.0) RETURN
        CYCNO = CYCNO - 1.0
        X3 = SIGMAX(I)
        X4 = SIGMIN(I)
        KFIRST = 1
        GO TO 113
111    X3 = SIGMAX(I)
        X4 = SIGMIN(I)
        IF (KFIRST .NE. 0) GO TO 113
        CYCNO = CYCNO - 1.0
        KFIRST = 1
113    IND3 = NSTEP(I)
        IND4 = IND3
        KMIN = 1
        KMAX = 0
        GO TO 10
1503    IF (KMAX .NE. 0) GO TO 1510
        IF (CYCNO .EQ. 0.0) RETURN
        CYCNO = CYCNO - 1.0
112    X4 = SIGMAX(I)
        IND4 = NSTEP(I)
        KMAX = 1
        KMIN = 0
        GO TO 11
1510    X4 = SIGMIN(I)
        IND4 = NSTEP(I)
        KMAX = 0
        KMIN = 1
        GO TO 10
        END
95

```

SUBROUTINE CYGGEN(Y1,Y2, CYCPF,NSTEPP)  
COMMON/MCYG/CYCLE(300,2),RNECYC(900),NNSTEP(900)  
COMMON/MCGDE/L,LIND

C  
C  
C  
C  
THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DATA  
SUPPLIED BY SUBROUTINE DECIDE

5  
10  
15  
20  
LIND = 6  
L = L + 1  
CYCLE(L,1) = Y1  
CYCLE(L,2) = Y2  
RNECYC(L) = CYCPF  
NNSTEP(L) = NSTEPP  
IF (L.EQ. 1) GO TO 100  
IF (CYCLE(L-1,1) .NE. CYCLE(L,1)) GO TO 130  
IF (CYCLE(L-1,2) .NE. CYCLE(L,2)) GO TO 130  
10 L = L - 1  
RNECYC(L) = RNECYC(L) + 1.0  
LIND = 1  
100 RETURN  
END

SUBROUTINE DEGRES(LRMAX, NCYNO)  
 COMMON/PCGDE/L, LIND  
 COMMON/DCGR/RES(1400), INDEX(1400), IND1, IND2, IND3, IND4, KIND  
 THIS SUBROUTINE DECIDES WHETHER OR NOT THE ELEMENTS OF THE RESIDUE  
 SPECTRUM SATISFY THE RANGE PAIR COUNTING CONDITIONS

K = 0  
 NCYNO = 0

X1 = RES(1)  
 X2 = RES(2)  
 X3 = RES(3)  
 X4 = RES(4)

IND1 = INDEX(1)  
 IND2 = INDEX(2)  
 IND3 = INDEX(3)  
 IND4 = INDEX(4)  
 J = 4

10 IF (X2 .GT. X1) GO TO 150  
 IF (X2 .LT. X4 .OR. X3 .GT. X1) GO TO 500  
 150 IF (X2 .GT. X3) GO TO 151  
 CALL CYCRES(X3, X2, 1, IND3)  
 GO TO 152

151 CALL CYCRES(X2, X3, 1, IND2)  
 152 NCYNO = NCYNO + 1  
 X1 = X1  
 X2 = X4  
 IND2 = IND4

IF (J .EQ. LRMAX) GO TO 300  
 IF ((J + 1) .EQ. LRMAX) GO TO 315  
 X3 = RES(J+1)  
 X4 = RES(J+2)  
 IND3 = INDEX(J+1)  
 IND4 = INDEX(J+2)  
 J = J+2  
 GO TO 10

100 IF (X2 .GT. X4 .OR. X3 .LT. X1) GO TO 500  
 GO TO 150

500 K = K + 1  
 RES(K) = X1  
 INDEX(K) = IND1  
 J = J + 1

IF (J .GT. LRMAX) GO TO 330

X1 = X2  
 X2 = X3  
 X3 = X4  
 X4 = RES(J)

IND1 = IND2  
 IND2 = IND3  
 IND3 = IND4  
 IND4 = INDEX(J)  
 GO TO 10

300 K = K + 1  
 RES(K) = X1  
 RES(K+1) = X2



SUBROUTINE DEGRES TRACE

```

60      INDEX(K) = IND1
        INDEX(K+1) = IND2
        LRMAX = K + 1
        RETURN
315     K = K + 1
        RES(K) = X1
        RES(K+1) = X2
        RES(K+2) = RES(J+1)
        INDEX(K) = IND1
65      INDEX(K+1) = IND2
        INDEX(K+2) = INDEX(J+1)
        LRMAX = K + 2
        RETURN
330     K = K + 1
        RES(K) = X2
        RES(K+1) = X3
        RES(K+2) = X4
70      INDEX(K) = IND2
        INDEX(K+1) = IND3
        INDEX(K+2) = IND4
        LRMAX = K + 2
        RETURN
75      END

```

SUBROUTINE CYCRES TRACE

PAGE

11/20/72 15.44.26.

CDC 6630 FTH V3.0-32.A OPT=0

SUBROUTINE CYCRES(Y1,Y2, CYC2F,NSTEPP)  
COMMON/MCYG/CYCLE(900,2),RNECYC(900),NNSTEP(900)  
COMMON/MCGDE/L,LIND

5 C THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DATA  
C SUPPLIED BY SUBROUTINE DECRES  
C

10 L = L + 1  
CYCLE(L,1) = Y1  
CYCLE(L,2) = Y2  
RNECYC(L) = CYCPF  
NNSTEP(L) = NSTEPP  
RETURN  
END